

GLOBAL MAGELLAN-IMAGE MAP OF VENUS AT FULL RESOLUTION; R. L. KIRK, K. B. EDWARDS, H. F. MORGAN, L. A. SODERBLOM, AND T. L. STOEWE, U.S. Geological Survey, Flagstaff, AZ 86001

Introduction During its first 243-day mapping cycle, the Magellan spacecraft succeeded in imaging 84% of the surface of Venus at resolutions on the order of 100 meters; subsequent cycles have increased the total coverage to over 97% and provided redundant coverage of much of the planet with differing viewing geometries [1]. Unfortunately, this full-resolution global dataset is in the form of thousands of individual orbit tracks (F-BIDRs) whose length-to-width ratio of nearly 1000 : 1 makes them minimally useful unless mosaicked. The Magellan project has produced full-resolution mosaics (F-MIDRs) only for selected regions on the planet, whereas a global set of mosaics has been made only at threefold degraded resolution (C1-MIDRs). Furthermore, although the F-MIDRs, which are approximately equidimensional, are much better suited for scientific interpretation than the F-BIDRs, they are still an unwieldy dataset: over 1500 quadrangles, each showing a region only about 600 km on a side, would be required to cover the entire planet. The USGS has therefore undertaken to produce and distribute a global, full-resolution set of mosaics of the Magellan image data in a format that will be efficient for both hardcopy and digital use.

The initial motivation for this project was that it would provide an efficient means of verifying the integrity of the F-BIDRs to be archived on computer-compatible tape at the USGS Flagstaff facility. However, the resulting product, known as the FMAP, should also serve as an important resource for future scientific interpretation. It will offer several advantages beyond global coverage at full resolution. The first, alluded to above, is its division of the planet's surface to minimize the number of quadrangles and maximize their area, subject to the limits on the number of pixels imposed by state-of-the-art digital recording media and hardcopy output devices. The second, the use of improved "cosmetic" processing techniques, will greatly reduce tonal discontinuities between component F-BIDRs in the FMAP compared to the standard Magellan mosaic products. Finally, wherever possible, the FMAP will incorporate data that were unavailable (e.g., because of processing delays) when the standard MIDR products were created, as well as data that have been reprocessed to improve their radiometric or geometric quality.

Quadrangle Scheme The FMAP, like the standard Magellan image products, will be compiled in Sinusoidal projection. Each of the 340 quadrangles will have a projection longitude in the center of its area of coverage. The accompanying figure shows the quadrangle scheme to be used for the FMAP. (Note that, because of the convergence of meridians in Sinusoidal projection, adjacent FMAP quadrangles will overlap slightly. The figure shows the midlines of the areas of overlap.) The quadrangles span approximately 12° in latitude except for those nearest the poles, which extend from ±84° to ±90°. Near the equator, the quadrangles also span approximately 12° in longitude, but the longitude range is increased at high latitudes to keep the width in pixels approximately constant. Data near the poles will also be reprojected and distributed in Polar Stereographic projection.

Quadrangles at different latitudes will differ slightly in their dimensions, but all will consist of approximately 17,000 lines and 17,000 samples, or slightly under 300 megabytes of data. It will therefore be possible to store one quadrangle on each side of an erasable magneto-optical disk during processing, and to distribute the digital FMAP on compact disk (CD-ROM) with two quadrangles per disk. To facilitate access to the data on CD-ROM, each quadrangle will be divided into sub-quadrangles or tiles approximately 2° (3000 pixels) on a side. All tiles in a given quadrangle will have a common projection longitude, making them easy to assemble into larger areas.

The hardcopy version of the FMAP will be output on Optronix 5040 large-format filmwriter at a resolution of 50 μ m per pixel. At this pixel size, the images are approximately 0.85 m on a side, well within the 1 m × 1.25 m capability of the filmwriter. The resulting negatives will be printed without enlargement, resulting in a map scale of 1 : 1,500,000.

Cosmetics Considerable effort has been devoted to the development of cosmetic techniques to suppress the artifacts—tonal gradients across the BIDR strips and tonal discontinuities between strips—that lead to mosaics with a "striped" appearance. First, we have developed a fairly complicated scheme for trimming the edges of the F-BIDRs before mosaicking. This scheme uses both *a priori* information (arrived at by trial and error) about the variation of the signal-to-noise ratio and the extent of overlap between BIDRs with latitude, and statistical testing of the data quality. The object is to trim away noisy image data that would lead to artifacts when the images are mosaicked, without trimming so deeply as to introduce gaps in the data. Second, after trimming the BIDRs, we highpass-filter them with a boxcar filter 1 sample wide by 701 lines (~50 km) tall. This process is relatively fast and removes systematic gradients in intensity across the BIDR (caused, for example, by misestimation of the antenna sensitivity pattern) without introducing significant artifacts even in areas where the surface displays strong backscatter contrasts. Finally, once the BIDRs are reprojected to a common center longitude, we blend the data in the area of overlap by using a

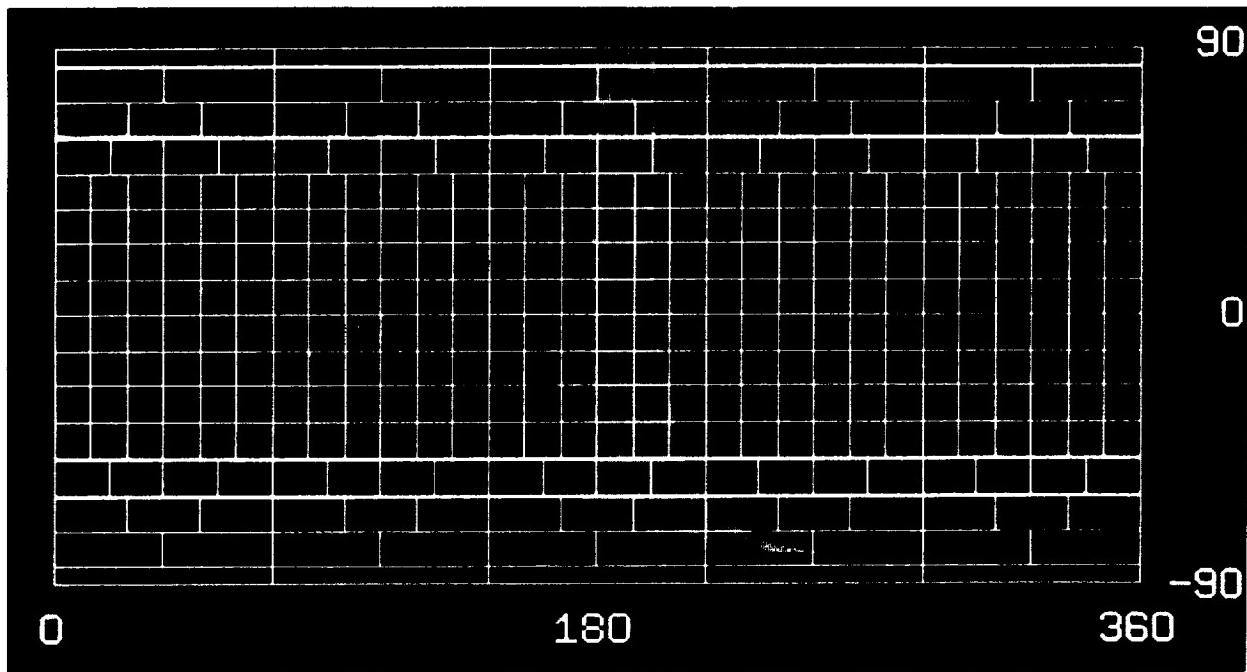
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slightly refined version of the feathering algorithm that was originally developed by Michael Girard of JPL and used in creating the Magellan MIDRs.

Production and Distribution The gray area in the figure below shows progress on the FMAP to date. Data are read in one BIDR at a time and incorporated into all quadrangles crossed by that BIDR; because of the roughly north-south alignment of Magellan's orbit, groups of about 10 quads tend to be completed simultaneously. Compilation of the FMAP is currently proceeding at a rate of roughly 10 orbits per day, which corresponds to an average output of eight quadrangles per week. Completed quadrangles are immediately output as continuous-tone negatives, and contact prints are generated and supplied to the Magellan project, the NSSDC, and the Regional Planetary Image Facilities (RPIFs).

Digital versions of the FMAP quadrangles are, for the moment, being archived in Flagstaff. Distribution of the data in digital form will be delayed in order to incorporate further improvements of the dataset (within reason). We anticipate that, by the end of FY93, some fraction of the quadrangles will have to be recompiled in order to incorporate currently unavailable or reprocessed BIDR data, or to correct unforeseen errors in the compilation process. In addition, efforts are currently underway to greatly improve the geodetic accuracy of the Magellan dataset by refining the spacecraft ephemeris through a combination of inter-orbit tiepointing and an improved model of the Venusian gravity field. Incorporation of the refined ephemeris would greatly increase the utility of the FMAP for future stereogrammetric studies (at present, navigation errors lead to artifactual "cliffs" up to several kilometers high in stereomodels of the surface). However, it is not yet clear whether the new navigation data will be available soon enough to be incorporated in the FMAP. Whatever the schedule, the FMAP CD-ROMs will be premastered by the Data Distribution Laboratory at JPL, produced by SONY, and distributed by the USGS to the RPIFs and all former Magellan investigators. Additional distribution will be handled by the Planetary Data System. Once the final data are compiled, they will also be published by the USGS as printed maps. The possibility for widespread distribution of such maps will greatly offset the loss of resolution inherent in the halftone printing process.

References Cited [1] R. S. SAUNDERS, et al. (1992) Magellan Mission Summary, *J. Geophys. Res.*, **97**, 13067-13090.



Global map of Venus in Simple Cylindrical projection, showing the division of the planet into 340 FMAP quadrangles. FMAP will be in Sinusoidal projection; overlap of quadrangles caused by convergence of meridians is not shown. Gray area shows data processed to date.